THE VARIABILITY OF TENDERS

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The paper describes the development of hypothetical models of tendering sets. Each tender is theorized as consisting of two variable components, the cost estimate and the mark-up, and in consideration of these variables, the concept of a "winning zone" is postulated.

Introduction

While a great deal of effort has been devoted, particularly by the Quantity Surveying profession, to analysing the differences between successful tenders for similar building projects, the difference between tenders submitted for any one building project has also been the cause of some debate particularly in the last 25 years. Those not familiar with the issues may question the relevance of these unaccepted tenders when faced with the reality of predicting the lowest tender. Consider then the effect on your prediction if the tender list was suddenly completely changed. Would you revise your prediction? Probably not, but it is virtually certain that the lowest tender submitted by the new set of tenderers will be different to that of the old list. Imagine this list being revised again and again, the lowest tender will vary each time, thus creating a distribution of possible lowest tenders.

As we are not in a position to gauge the effect of different groups of tenders then it is obviously impossible to predict the lowest tender with any certainty. In other words the situation is non-deterministic. The best we can hope to achieve therefore is a range of values within which the lowest tender can be expected to fall.

So far we have considered only the lowest tenders, why then are the non-lowest tenders important?

Consider, say a population of 20 potential tenderers from which we intend to select samples of 6 to submit tenders. Let us also say that the tenderers in each sample are chosen at random from the 20 available, then it will be apparent that the sample containing the lowest tenders will consist of the 6 lowest potential tenders from the population. Conversely, the sample containing the highest tenders will consist of the 6 highest potential tenders from the population. If we group the tenderers into ascending order of

potential values starting with tenderer no. 1 as the lowest to tenderer no. 20 as the highest then the frequency distribution of the tenderers' success from all possible combinations of 6 tenderers will be as shown in Table 1 and Figure 1. Thus it can be seen that the lowest tenderer may be anywhere between tenderer no. 1 and 15 but with decreasing frequency (probability). The cumulative probability distribution shown in Figure 2 indicates 7 lowest potential tenderers to be contained within the 0.95 probability band (confidence limit), normally accepted as sufficiently accurate, at least for statistical purposes. Where tenderers are chosen at random therefore it will be necessary to seriously consider the possibility of any of these 7 tenderers becoming successful. In other words, the lowest tender will be within a range of tenders depending on which tenderers are selected. It is perhaps interesting to note that, on this basis, the lowest 2 potential tenderers have only slightly more than an even chance of even being allowed to put in a bid. It is, of course possible though, that the selection of the tenderers in the sample will be rather better than simply random choice, thus reducing the range of potentially low tenders.

Increasing the number of tenderers allowed to compete and/or a reduced population size will have the same effect.

Variability Between Tenders

It is commonly theorized that tenders comprise values allocated to two mutually exclusive components, the cost estimate and the mark-up. Researchers have been remarkably ambivalent in their attitude to the nature of these components. Many assume the mark-up to be the distinguishing variable between tenders whilst the cost estimate remains constant. Others have assumed the reverse to apply, that the cost estimate varies between tenderers with the mark-up percentage remaining constant. Figure 3 models the four possible combinations of fixed and variable cost estimates and mark-ups. Model 1 shows the theoretical but absurd position where the cost estimate and mark-up are fixed for each tenderer, resulting in identical tenders. Model 2 indicates the classical view, where the cost estimates are assumed to be equal, mark-ups being drawn from a distribution of mark-ups, in this example between 0 and 15%, but most probably around 7½%. Model 3 illustrates the position where the cost estimate is variable and the mark-up is fixed, an assumption often made by simulators in investigating the effect of low cost estimates.

The variability in the cost estimate in this model is taken to be around ± 10%, a figure considered to be appropriate in many circles. The effect of the fixed mark-up in this case can be seen to simply shift the distribution up the value scale. Finally Model 4 indicates the composite position where both the cost estimate and mark-up are considered as variables. Using the same distributions and ranges of values the tender distribution has become much flatter because of the combined variabilities. It may be noted that only in Model 1, the absurdity, is the tender value a single determinable figure. Models 2 - 4 are probabilistic, in that a range of possible values is obtainable. There is no factual evidence, however, to support the notion that probabilities can be assigned to any of the values in the distributions, the probabilistic models displayed having being used for demonstration purposes only. Whilst Model 1 is absurd, Models 2 and 3 are intuitively regarded as false. Cost estimates can differ for many reasons including relative efficiency, errors, chance variations, and the effects of perceived uncertaintly. Mark-up on the other hand is recognised by the C.I.O.B.[1] and others, as being the only manipulative strategic variable in a competitive environment. It is appropriate at this stage therefore to regard Model 4 as intuitively "correct".

Variability Within Tenders

The four models presented in Figure 3 can also be considered in relation to the potential range of tenders available to an individual tenderer. If the tenderer were to calculate his cost estimate several times over, it is highly unlikely he would arrive at the same figure twice. Variations would occur, certain rough guesses would have different values, perceived uncertainty may be inconsistent. To the Quantity Surveyor, the mark-up is also a variable in that although it may not be strictly random, it is still drawn from a population of mark-ups. Again Model 4 is undoubtedly the best representation, except in the unlikely case where the Quantity Surveyors can establish a tenderer's mark-up, in which case Model 3 will apply.

Combined Variability Between and Within Tenders

Figure 4 shows the superficial difference between 3 tenders for a project. The hypothetical models discussed above however suggest that the observa-

tions displayed in Figure 4 are merely values drawn from individual populations of potential tenders represented in Figure 5 as 3 unique probability distributions. The distributions are unique in two ways 1) proximity, the relative central tendencies of the distributions represent the relative efficiences of the tendering organisation i.e., the inherent ability of one firm to do the work at a different cost to its competitors and 2) shape, the flatter distribution, as noted by Bennett and Barnes[2] indicating a greater perceived uncertainty for tenderer B than his competitors, or perhaps a rather unreliable estimating department.

It can be seen from Figure 5 that no tender less than B's lowest nor higher than A's highest can win the competition. Between these limits lies a continuum of potential winning tenders, the "winning zone", illustrated in Figure 6. In every tendering competition such a winning zone exists and it is from this zone that the lowest tender will occur. It is in the nature of the Quantity Surveyor's business, therefore, to attempt to predict the position of the lowest tender along the continuum. The model is probabilistic in assuming a central tendency exists (the apex of the "winning zone"), the assignment of probabilities or even the location of the continuum however is problematic.

Conclusions

It has been shown that random selection of tenderers decreases the predictability of the lowest tender by decreasing the chances of including potentially low tenders. Conversely, increasing the number of tenderers or operating within a low tenderer population will increase predictability. In all cases knowledge of the tenderer population will be important.

Models have been developed to provide a base for research into the effect of tender variability on prediction of lowest tenders. The models account for within and between tender variability and the "winning zone" concept has been introduced in which the lowest tender is hypothesised to fall within a continuum of potential lowest tenders. The models are presented expediently as probabilistic.

Methological Note

The development of the models concludes an extensive review of published

literature, a selected bibliography of which is available from the writer. Whilst little empirical evidence has been considered, since such evidence is palpably lacking in this field, the models are considered to be generally epistemologically valid. It is appreciated that Quantity Surveyors are essentially pragmatists and some empirical research has been conducted. One such research programme concerning the relative variability of cost estimates and mark-ups has been completed at the University of Salford, details of which will be published at a later date.

References

1. C.I.O.B. Code of Estimating Practice 4th ed. The Chartered Institute of Building. 1979.

2. BENNETT, PROFESSOR JOHN AND BARNES, DR MARTIN. Chartered Quantity Surveyor vol. 2, No. 3. Oct. 1979, p. 53-56. "Six factors which influence bills: Outline of a theory of measurement".

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TABLE 1 Results of tendering competitions with 6 tenderers from a population of 20

Tenderer No.	Competitions		Probability of success (P)	
	Entered (A)	Won	(A)/38760	$\Sigma_{(P)}$
1	11628	11628	0.300	0.300
2	11628	8568	0.221	0.521
3	11628	6188	0.160	0.681
4	11628	4368	0.113	0.794
5	11628	3002	0.077	0.871
6	11628	2002	0.052	0.923
7	11628	1287	0.033	0.956
8	11628	792	0.020	0.976
9	11628	462	0.012	0.988
10	11628	252	0.007	0.995
11	11628	126	0.003	0.998
12	11628	56	0.001	0.999
13	11628	21	0.001	1.000
14	11628	6	0	1.000
15	11628	1	0	1.000
16	11628	0	0	1.000
17	11628	0	0	1.000
18	11628	0	0	1.000
19	11628	0	0	1.000
20	11628	0	0	1.000
	TOTAL	38760	1.000	

FIGURE 1 Frequency of Success of Tenderers (from Table 1)

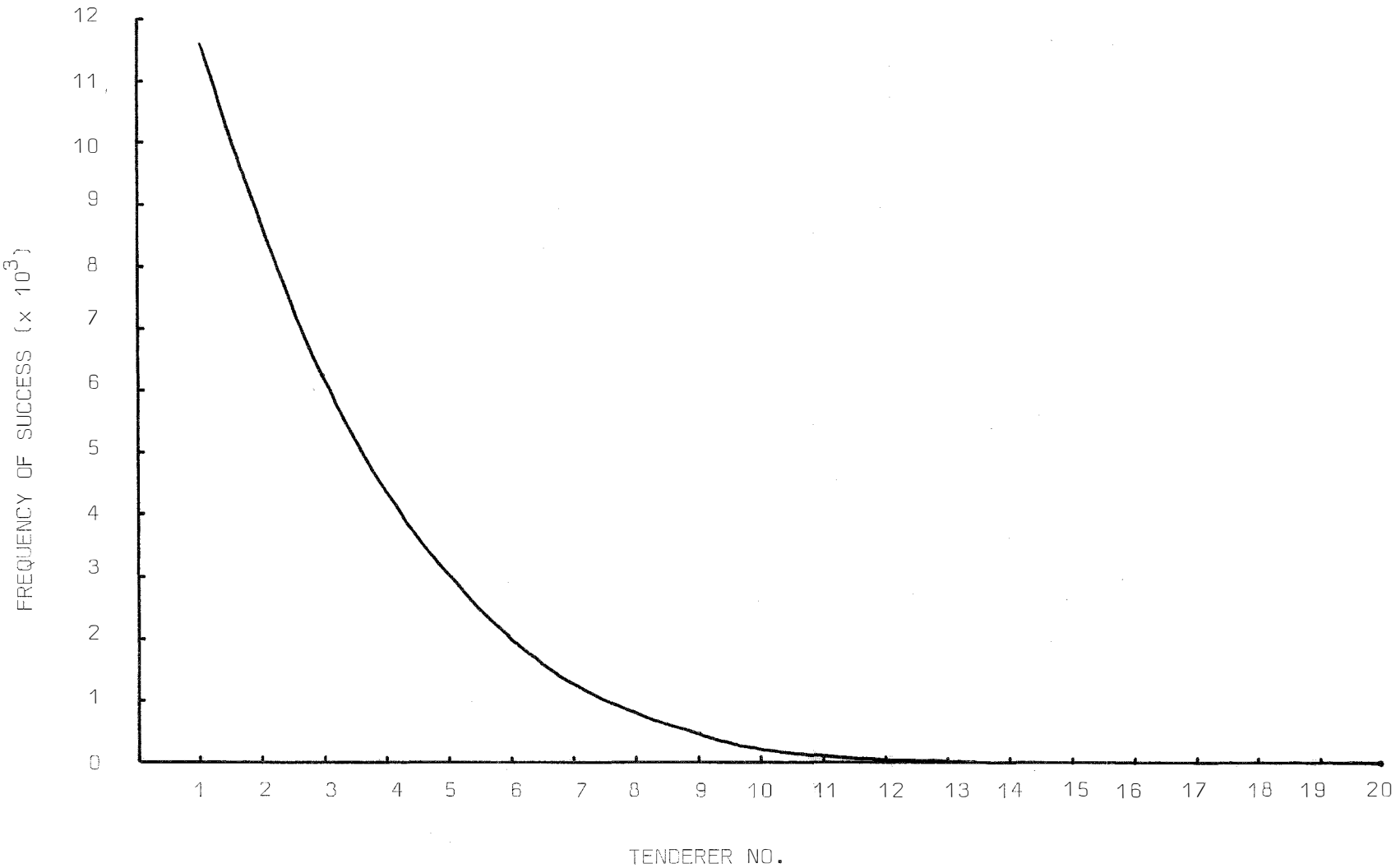


FIGURE 2 Cumulative Probability Distribution of Successful Tenderers (from Table 1)

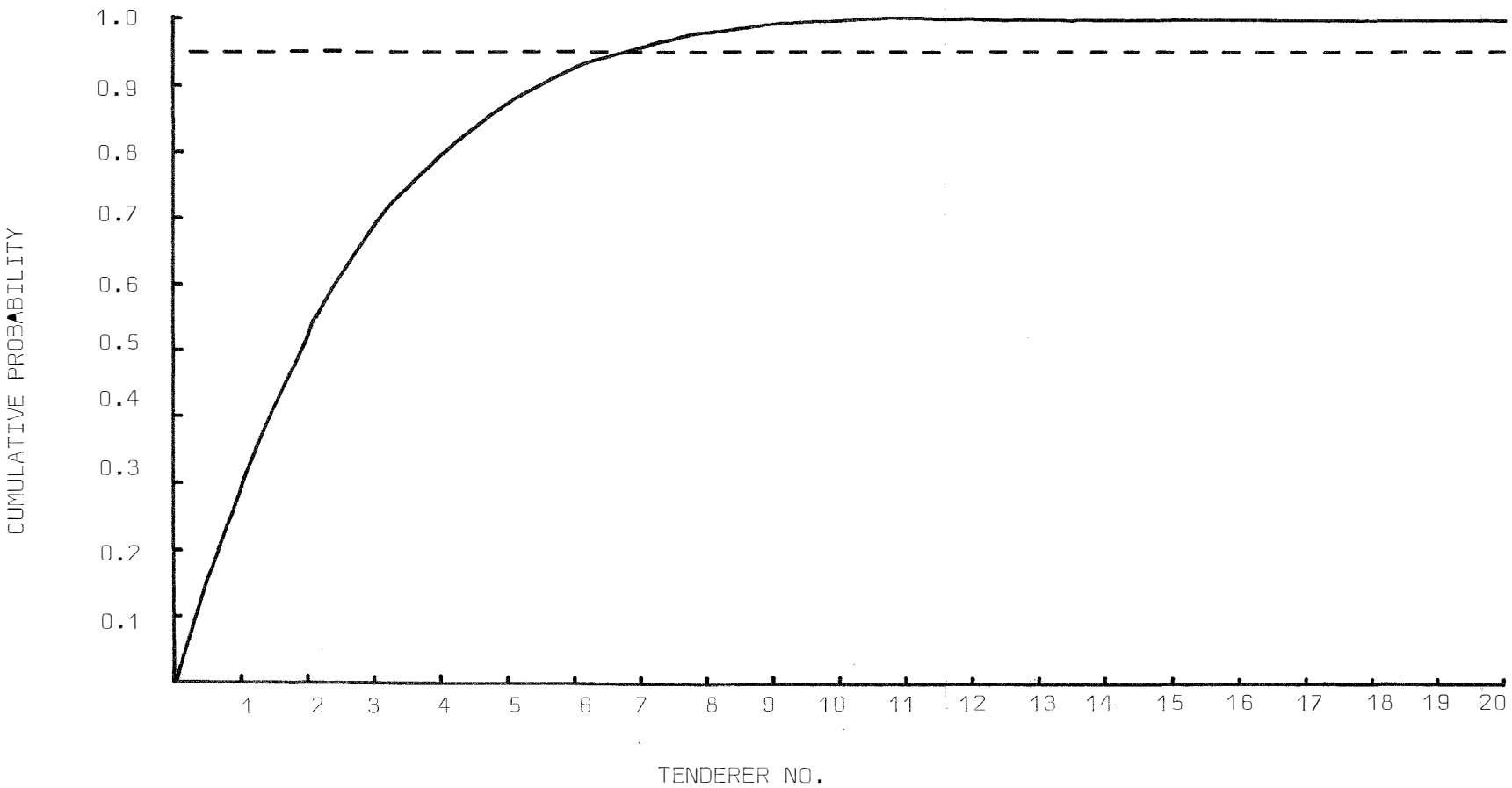
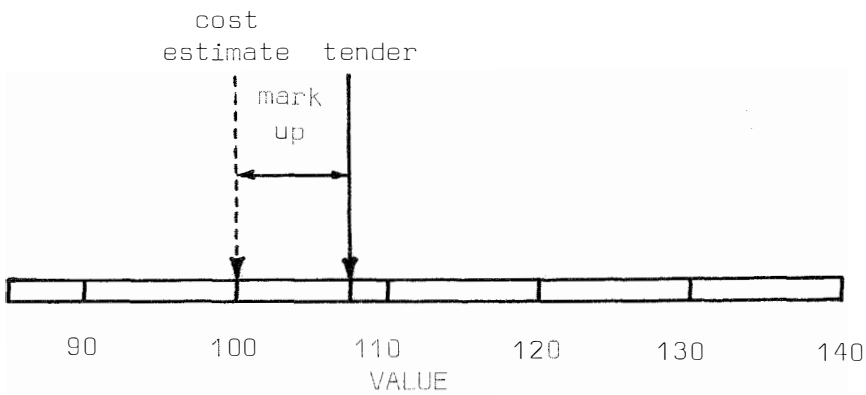
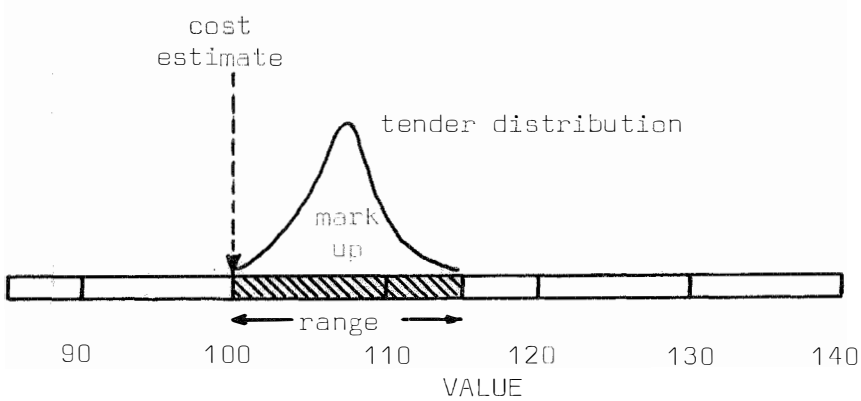


FIGURE 3 The Effect of Component Variability on Tender Variability

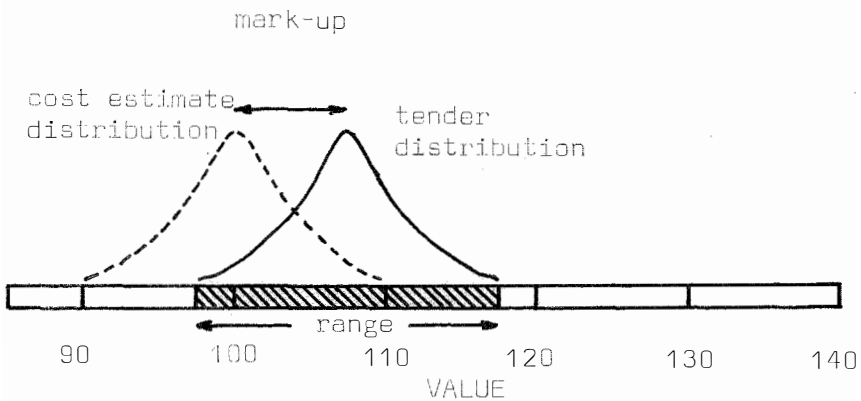
Model 1. Fixed cost estimate and mark-up.



Model 2. Fixed cost estimate, variable mark-up.



Model 3. Variable cost estimate, fixed mark-up.



Model 4. Variable cost estimate and mark-up.

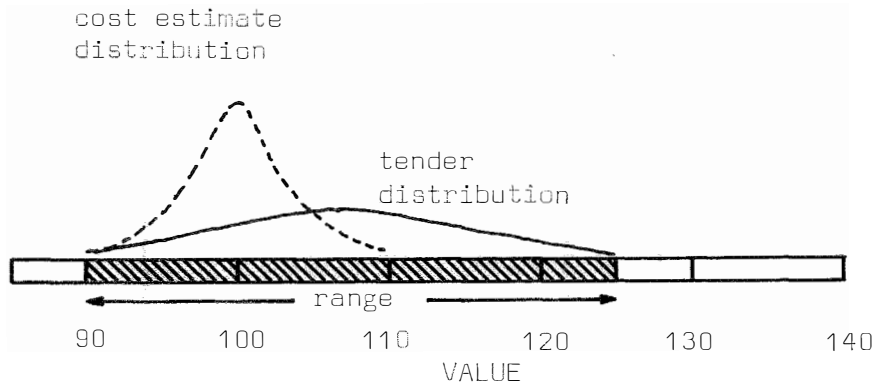


FIGURE 4 The Observed Relationship Between Tenders from Several Tenderers

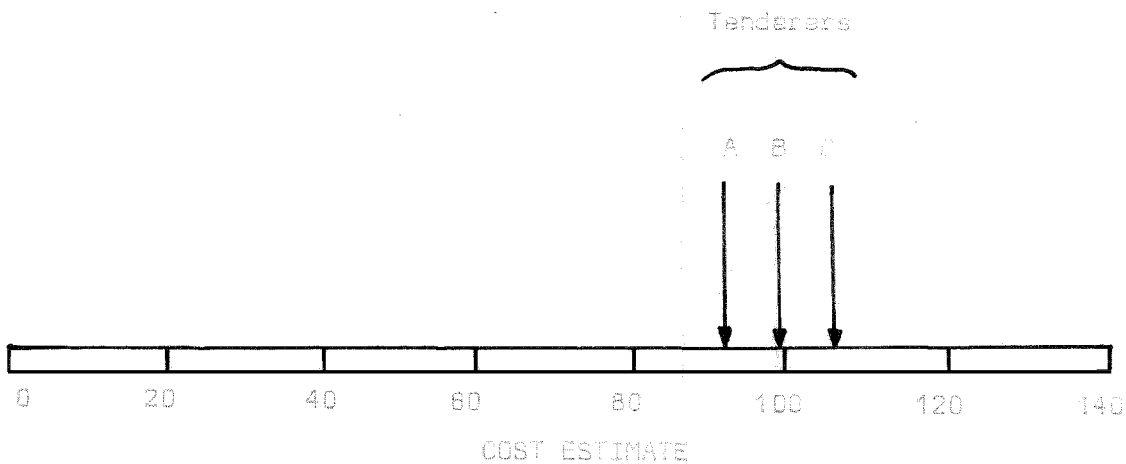


FIGURE 5 The Relationship Between Underlying Distributions of Tenders for Several Tenderers

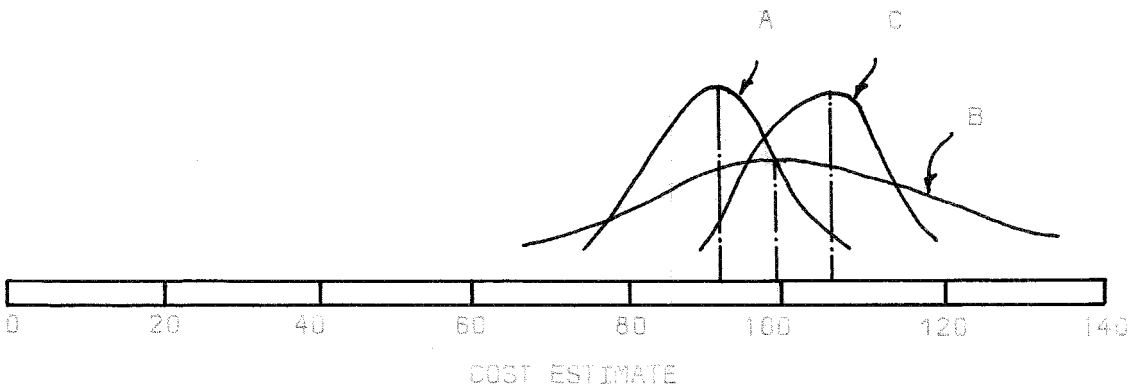
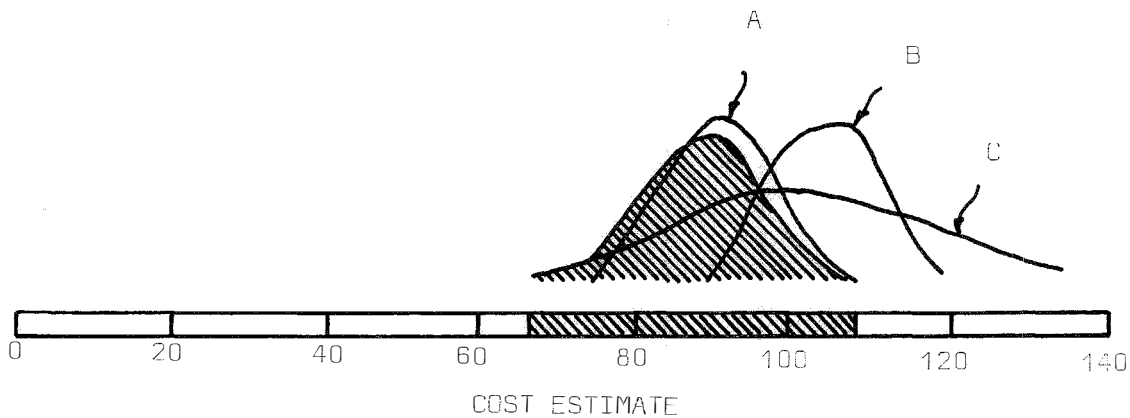


FIGURE 6 The Relationship Between Underlying Distributions of Tenders for Several Tenderers



Shaded area - distribution in which winning estimate will be found (winning zone)